CLAIMS

1. A molding die for molding an integrated optical circuit (IOC), said IOC including at least one optical waveguide, the molding die comprising:

a substrate having a topographically patterned first surface; and

a conformal protective film provided over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC to be molded using the molding die.

2. The molding die of claim 1, wherein said first surface includes at least one vertical wall having a top and a bottom, and at least one step in the wall between the top and bottom.

3. The molding die of claim 1, wherein said protective film is selected from the group of metal, aluminum oxide, and diamond.

4. The molding die of claim 1, wherein said protective film is selected from the group of nickel and titanium.

5. The tool of claim 1, wherein said substrate is made of material selected from the group of silicon, silicon-nitride, silicon carbide, and gallium arsenide.

6. A tool for molding an IOC, said IOC including at least one optical waveguide, the tool comprising:

a roller having the shape of a cylinder with a curved outer surface;

at least one substrate having a topographically patterned first surface; and

a conformal protective film provided over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC, said substrate being applied onto the curved outer surface of the roller with said second surface facing outwards.

7. The tool of claim 6, wherein said protective film is made of material selected from the group of metal, aluminum oxide, and diamond.

8. The tool of claim 7, wherein said substrate is made of material selected from the group of silicon, silicon-nitride, silicon-carbide, and gallium arsenide.

9. The tool of claim 8, wherein said substrate is bent to conform to the curved outer surface of said roller.

10. The tool of claim 6, wherein said substrate is made of material selected from the group of silicon, silicon-nitride, silicon-carbide, and gallium arsenide.

11. The tool of claim 10, wherein said substrate is bent to conform to the curved outer surface of said roller.

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12. A method for making a substrate for molding an IOC, said IOC including at least one optical waveguide, the method comprising:

providing a substrate, said substrate having a first surface;

patterning said first surface so that said first surface has a topographical pattern; and

providing a conformal protective film over the topographical pattern of the first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC to be molded using the molding die.

13. The method of claim 12, wherein said protective film is metal and is provided by plating the metal onto said first surface.

14. The method of claim 12, wherein said first surface includes at least one vertical wall having a top and a bottom, and said first surface includes at least one intermediate step in the wall between said top and said bottom.

15. A method for making a tool for molding an IOC, said IOC including at least one optical waveguide, the method comprising:

providing a roller having the shape of a cylinder with a curved outer surface;

providing at least one substrate having a topographically patterned first surface;

providing a conformal protective film over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC; and

applying said substrate onto the curved outer surface of the roller with said second surface facing outwards.

16. The method of claim 15, wherein said protective film is made of material selected from the group of metal, aluminum oxide, and diamond.

17. The method of claim 16, wherein said substrate is made of material selected from the group of silicon, silicon -nitride, silicon-carbide, and gallium arsenide.

18. The method of claim 17, further comprising bending said substrate to conform to the curved outer surface of said roller.

19. The method of claim 15, wherein said substrate is made of material selected from the group of silicon, silicon -nitride, silicon-carbide, and gallium arsenide.

20. The method of claim 19, further comprising bending said substrate to conform to the curved outer surface of said roller.

21. The method of claim 15, further comprising:

providing a semiconductor wafer with a first surface;

etching said first surface so as to form a plurality of molding die on said first surface with a topographical pattern on each molding die;

providing a conformal protective film over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of an IOC on each molding die; and

cutting said wafer into a plurality of parts, each part forming at least one said substrate.

22. The method of claim 21, wherein said protective film is metal, and further comprising applying said conformal protective film to said first surface by plating the metal onto said first surface.

23. The method of claim 21, wherein said wafer comprises silicon or gallium arsenide, and further comprises thinning said wafer by removing material from a surface of the wafer opposite the first surface.

24. A method for compression-molding an IOC, said IOC including at least one optical waveguide, the method comprising:

providing at least one substrate having a topographically patterned first surface and a conformal protective film provided over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC;

providing a holding substrate with a surface;

providing a moldable first material on said holding substrate;

heating one or both of said molding die and said first material;

pressing said patterned second surface into said first material at a selected pressure, thereby molding a patterned IOC surface; and

curing the first material.

25. The method of claim 24, wherein said protective film is made of material selected from the group of metal, aluminum oxide, and diamond.

26. The method of claim 25, wherein said substrate is made of material selected from the group of silicon, silicon-nitride, silicon-carbide, and gallium arsenide.

27. The method of claim 24, wherein said first material is optically transmitting.

28. The method of claim 24, wherein said IOC surface includes at least one channel, and the method further comprises:

providing a moldable second material, said second material being optically transmitting and having an optical index of refraction that is higher than that of said first material;

filling at least one channel in said IOC surface with the second material; and curing the second material.

29. The method of claim 24, wherein said first material comprises a plurality of layers, said layers including a surface layer that is molded to form said IOC surface and an optical confinement layer located beneath said surface layer, said confinement layer having an index of refraction that is less than that of said surface layer, said plurality of layers being made of materials selected from the group of thermosetting polymer, thermoplastic, and photo-polymer.

30. A method for compression-molding an IOC, said IOC including at least one optical waveguide, the method comprising:

providing a molding tool, said molding tool including a roller having the shape of a cylinder with a curved outer surface, at least one substrate having a topographically patterned first surface, and a conformal protective film provided over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC, said substrate being applied onto the curved outer surface of the roller with said second surface facing outwards;

providing a tape of moldable first material;

heating one or both of said molding tool and said tape;

rolling said molding tool over said tape, said molding tool applying a selected pressure to said tape, thereby molding a patterned IOC surface; and

curing the first material.

31. The method of claim 30, wherein said patterned first material is optically transmitting.

32. The method of claim 30, wherein said IOC surface includes at least one channel, and the method further comprises:

providing a moldable second material, said second material being optically transmitting and having an optical index of refraction that is higher than that of said first material;

filling at least one channel in said IOC surface with the second material; and curing the second material.

33. The method of claim 30, wherein said first material comprises a plurality of layers, said layers including a surface layer that is molded to form said IOC surface and an optical confinement layer located beneath said surface layer, said confinement layer having an index of refraction that is less than that of said surface layer, said plurality of layers being made of materials selected from the group of thermosetting polymer, thermoplastic, and photo-polymer.

34. The method of claim 30, wherein said protective film is made of material selected from the group of metal, aluminum oxide, and diamond, and said substrate comprises silicon or gallium arsenide; and

further comprising bending said substrate to conform to the curved outer surface of said roller.

35. A method for molding an IOC, said IOC including at least one optical waveguide, the method comprising:

providing a mold having a cavity defined by an interior surface;

providing at least one substrate having a topographically patterned first surface and a conformal protective film provided over said first surface, said film having an outer second surface, wherein said second surface forms a negative copy of the IOC, said substrate being applied onto said interior surface with said second surface facing towards the cavity;

injecting a moldable first material into the cavity so that said first material contacts and conforms to said second surface, thereby molding a patterned IOC surface;

curing the first material; and

removing the first material from said cavity.

36. The method of claim 35, wherein said first material is optically transmitting.

37. The method of claim 35, wherein said IOC surface includes at least one channel, and the method further comprises:

providing a moldable second material, said second material being optically transmitting and having an optical index of refraction that is higher than that of said first material;

filling at least one channel in said IOC surface with the second material; and

curing the second material.

38. The method of claim 35, wherein said protective film is made of material selected from the group of metal, aluminum oxide, and diamond, and said substrate is selected from the group of silicon or gallium arsenide, and

further comprising bending said substrate to conform to the curved outer surface of said roller.